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102D CONGRESS
1st Session

SENATE

REPORT
102-217

GEOLOGIC MAPPING ACT OF 1991

NOVEMBER 15, (legislative day, NOVEMBER 13), 1991.—Ordered to be printed

Mr. JOHNSTON, from the Committee on Energy and Natural Resources, submitted the following

REPORT

[To accompany S. 1179]

The Committee on Energy and Natural Resources, to which was referred the bill (S. 1179), to stimulate the production of geologic map information in the United States through the cooperation of Federal, State, and academic participants, having considered the same, reports favorably thereon with amendments and recommends that the bill, as amended, do pass.

The amendment are as follows:

1. On page 4, line 9, add "United States" prior to "Virgin Islands" and on line 11, add before "Mariana Islands" the word "Northern".

2. On page 4, line 22 delete the number "eight" and insert the number "five".

3. On page 5, line 22, delete all of paragraph (2) and renumber the following paragraphs accordingly.

4. On page 7, line 7, add a new subparagraph before subsection (c) as follows:

> (E) the degree to which geologic mapping activities traditionally funded by the United States Geologic Survey, including the use of commercially available aerial photography, professional surveying, photogrammetric mapping and related services, can be contracted out to professional private mapping firms.

5. On page 8, line 13 delete "partners." and insert "partners as established in paragraph (2)."

6. On page 8, line 19, delete "consist of" and insert "consist of representatives from".

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2. On page 9, line 1, delete all of paragraph (3) and insert in lieu thereof the following:

> (3) There is hereby established a sixteen-member geologic mapping advisory group to evaluate annually the scientific progress of the geologic mapping program. The advisory group shall consist of the Administrator or Secretary of the Environmental Protection Agency, the Department of Energy, the Department of Agriculture, the Department of the Interior and the Director of the President's Office of Science and Technology. The Secretary shall, within 90 days and with the advice and consultation of the State Geologic Surveys, appoint the remaining member of the advisory group from the mapping partners, academia, the private sector and the State Geological Surveys. As its first task, the advisory group shall review and critique the implementation plan prepared by the Secretary pursuant to subsection (f) of this section. The advisory group shall provide an annual report to the Secretary, evaluating the progress of the Federal and State mapping activities and evaluating the progress made toward fulfilling the purposes of this Act. The Secretary shall incorporate the advisory group report in the report required pursuant to section 8 of this Act.

8. On page 11, line 2, delete "(1)".
9. On page 11, line 3, delete "(2)".
10. On page 11, line 13 delete "Data Base;" and insert "Data Base; the U.S. Geological Survey is encouraged to acquire, archive, and use Side-Looking Airborne Radar (SLAR) or Interferometric Synthetic Apeture Radar (IFSAR) data whenever it is technically appropriate for geologic or related mapping studies;".
11. On page 12, line 9, delete "to be (A)".
12. On page 12, line 10, delete "the".
13. On page 12, line 12, delete "(B)".
4. On page 12, line 12, delete "to provide for graduate education, including support for field studies involving geologic mapping." and insert in lieu thereof the following: "to provide for broader education in geologic mapping and field analysis through support of field teaching institutes."
5. On page 14, line 21, delete paragraph (6) and renumber the remaining paragraphs accordingly.

PURPOSE

The purpose of S. 1179 is to direct the Secretary of the Interior to establish a national geologic mapping program to expedite geologic map production. The legislation provides mechanisms for coordination between the U.S. Geological Survey, the State Geological Surveys and academia, and establishes Federal, State, Support, and Education program elements.

BACKGROUND AND NEED

Geologic mapping involves the gathering of information about surface occurrences of rocks, minerals, and other materials at or

near the surface of the earth and plotting this data on maps. Geologic maps are prepared from field surveys and other sources of geologic information; they include distribution, nature and age of rock and surface materials, occurrence of faults and folds, mineral deposits, and other geologic factors that affect man's activities.

Geologic maps are the principal source of geologic information needed for the resolution of many basic and applied earth-science research and decision-making problems. A geologic map provides fundamental geologic information, indicates mineral-resource potential, and is a guide to most human activities. Examples are distribution and availability of energy and mineral resources, location and nature of natural hazards, distribution and availability of water resources, and availability and limitations of land and water for various uses. Applications include screening and site characterization for toxic and nuclear waste disposal sites, earthquake hazard reduction studies, landslide hazard assessments, volcanic hazard reductions, critical facilities siting, evaluation of excessive coastal erosion and basic earth-science research. Geologic maps contain many of the basic data needed for planning many engineering construction jobs such as dam and reservoir sites, highways, railroads, pipelines, bridges, industrial plants, location of construction materials, and avoiding areas prone to landslides, unstable foundations, and similar earth-rock problems. Users of geologic maps include Federal, state and local governments, private industry, and academia.

A National Academy of Sciences report ("Geologic Mapping—Future Needs" 1988), found that users of geologic maps attach a high level of importance to geologic maps and foresaw a significant increase in the need for such maps in the future. The users indicated that the need for geologic maps of a medium to large scale (less than 1:62,500) was most important.

The U.S. Geologic Survey National Geologic Mapping Program is the core program in the U.S. Geologic Survey that produces general purpose geologic maps and their derivative map products for the Nation. The fiscal year 1991 National Geologic Mapping Program supports the production of 281 maps (150 at 1:24,000 scale, 25 at 1:48–1:62,500 scale, and 106 at 1:100,000 scale). Funding for the program for fiscal year 1991 was $21.273 million.

According to the Association of American State Geologists (AASG), current combined Federal and non-Federal geologic mapping capability is not adequate to meet the geologic mapping needs of the Nation. Only these areas, Kentucky, Massachusetts and Puerto Rico essentially have complete geologic map coverage at a scale of 1:24,000.

LEGISLATIVE HISTORY

S. 1179 was introduced on May 23, 1991, and a hearing was held on July 30, 1991.

COMMITTEE RECOMMENDATIONS AND TABULATION OF VOTE

The Senate Committee on Energy and Natural Resources, in open business session on Wednesday, October 30, 1991, by unani-

mous vote of quorum present, recommended that the Senate pass the bill as described herein.

The rollcall vote on reporting the measure was 20 yeas and 0 nays, as follows:

YEAS	NAYS
Mr. Johnston	
Mr. Bumpers	
Mr. Ford [1]	
Mr. Bradley [1]	
Mr. Bingaman	
Mr. Wirth	
Mr. Conrad	
Mr. Akaka [1]	
Mr. Fowler [1]	
Mr. Shelby [1]	
Mr. Wellstone [1]	
Mr. Wallop	
Mr. Hatfield	
Mr. Domenici	
Mr. Murkowski	
Mr. Nickles [1]	
Mr. Burns	
Mr. Craig	
Mr. Seymour [1]	
Mr. Garn	

[1] Indicates proxy vote.

COMMITTEE AMENDMENTS

1. The first amendment is technical is nature.

2. The second amendment is technical is nature.

3. The third amendment is a conforming amendment.

4. The fourth amendment requires the Secretary to include in the report to Congress required by paragraph (b)(3) the degree to which certain geologic mapping activities can be contracted out to professional private mapping firms.

5. The fifth amendment is a clarifying amendment.

6. The sixth amendment is a clarifying amendment.

7. The seventh amendment clarifies that the legislation establishes the advisory group and that the Secretary shall appoint the non-Federal representatives to the advisory group.

8. The eighth amendment is technical in nature.

9. The ninth amendment is technical in nature.

10. The 10th amendment encourages the U.S. Geological Survey to use certain radar imagery techniques as tools in the geologic mapping program.

11. The 11th amendment is technical in nature.

12. The 12th amendment is technical in nature.

13. The 13th amendment is technical in nature.

14. The 14th amendment changes and clarifies the objectives of the Education component of the geologic mapping program established in the legislation by including undergraduate as well as graduate education in geologic mapping and field analysis, through the support of field teaching institutes.

15. The 15th amendment deletes a requirement that the U.S. Geological Survey provide, as part of the implementation plan, a staffing plan.

SECTION-BY-SECTION ANALYSIS

Section 2 states Congress's findings and is self-explanatory.

Section 3 provides that the purpose of the Act is to expedite the production of a geologic-map information base which can be applied to resolution of issues related to land-use management, assessment, utilization and conservation of natural resources, ground water management, and environmental protection.

Section 4 provides definitions and is self-explanatory.

Subsection 5(a) provides that the Secretary of the Interior ("Secretary") shall establish and maintain, in accordance with the provisions and policy of the Act, a comprehensive nationwide geologic mapping program. The rest of the subsection is self-explanatory.

Subsection 5(b) provides that the Secretary shall (1) designate the U.S. Geological Survey as the lead Federal agency responsible for overall management of the nationwide geologic mapping program and direct the U.S. Geological Survey to develop the program implementaton plan pursuant to subsection (f); (2) submit to Congress the implementation plan described in subsection (f); (3) submit a report to Congress identifying (A) how the U.S. Geological Survey will coordinate the development and implementation of the nationwide geologic mapping program; (B) how the association of geologic mapping partners will coordinate to jointly develop the national geologic-map data base; (C) how the U.S. Geological Survey, in cooperation with all partners of the geologic mapping association, will establish goals, mapping priorities, and target dates for implementation of the geological mapping program; (D) how long-term staffing plans for various geologic mapping program components will lead to successful implementation of such program; and (E) the degree to which geologic mapping activities traditionally funded by the U.S. Geological Survey, including the use of commercially available aerial photography, professional surveying, photogrammetric mapping and related services, can be contracted out to professional private mapping firms.

Subsection 5(c) provides that the objectives of the geologic mapping program shall include (1) determination of the Nation's geologic framework through systematic development of geologic maps to be contributed to a national geologic map data base, at scales appropriate to the geologic setting and the perceived application, for the purpose of resolving issues related to land use management, assessment, utilization and conservation of natural resources, ground water management, and environmental protection; (2) establishment of a geologic mapping association whose cooperating partners coordinate to identify national priorities and to develop the national geologic-map base; (3) development of complementary geophysical, geochemical, geochronologic, and paleontologic data bases that provide value-added descriptive and interpretive information to the geologic-map data base; (4) application of cost-effective mapping techniques that assemble, produce, translate, and disseminate geologic-map information and that render such information of greater

application and benefit to the public; and (5) development of public awareness for the role and application of geologic-map information to the resolution of national issues of land use management.

Paragraph 5(d)(1) provides that the geologic mapping program shall be directed by the U.S. Geological Survey and carried out by an association of geologic mapping partners as established in paragraph (2). The association collectively shall identify mutual priorities, coordinate so as to maximize productivity and avoid redundancy, and maintain the long-term growth of the national geologic-map data base.

Paragraph 5(d)(2) provides that the mapping association shall be established by the Secretary and shall consist of representatives from the U.S. Geological Survey, the individual State Geological Surveys, and scientists from the academic community. In developing the association the Secretary shall identify mechanisms to incorporate the various participants into the program while recognizing and protecting the participants' unique needs and missions.

Paragraph 5(d)(3) establishes a sixteen-member geologic mapping advisory group to evaluate annually the scientific progress of the geologic mapping program. The advisory group shall consist of the Administrator or Secretary of the Environmental Protection Agency, the Department of Energy, the Department of Agriculture, the Department of the Interior and the Director of the President's Office of Science and Technology. The Secretary shall, within 90 days and with the advice and consultation of the State Geologic Surveys, appoint the remaining members of the advisory group from the mapping partners, academia, the private sector and the State Geological Surveys. The rest of the paragraph is self-explanatory.

Subsection 5(e) provides that the geologic mapping program elements shall include (1) a Federal Geologic Mapping component, the objective of such component to be to determine the geologic framework of areas determined to be vital to the economic, social, or scientific welfare of the Nation. Mapping priorities shall be based on (A) national requirements for geologic map information in areas of multiple-issue need or areas of compelling single-issued need; and (B) national requirements for geologic-map information in areas where mapping is required to solve critical earth-science problems; (2) a Geologic Mapping Support Component, the objective of such component to be to provide interdisciplinary support for the Federal Geologic Mapping Component; the rest of the paragraph is self-explanatory; (3) a State Geologic Mapping Component, the objective of such component to be to determine the geologic framework of areas that the State Geological Surveys determine to be vital to the economic, social, or scientific welfare of individual States. Mapping priorities shall be determined by multirepresentational State panels, and these priorities shall provide mapping targets for State-funded geologic mapping activities. Federal funding for the State component shall be matched on a one-to-one basis with non-Federal funds; (4) a Geologic Mapping Education Component, the objective of such component to develop academic programs that teach earth-science students the fundamental principles of geologic mapping and field analysis, and to provide for broader education in geologic-

mapping and field analysis through support of field teaching institutes. The rest of the paragraph is self-explanatory.

Subsection (f) provides that the Secretarty shall direct the U.S. Geological Survey, with the advice and review of the advisory group, to prepare an implementation plan that shall identify the overall management structure and operation of the nationwide geologic mapping program. The plan shall be completed within ninety days of enactment of this Act. The plan shall provide for (1) the role of the cooperating partners within the Geologic Mapping Association, with particular emphasis on development of a unified program that serves the public interest while simultaneously recognizing the unique need and missions of each partner; (2) the role of the U.S. Geological Survey in its capacity as overall management lead, including the responsibility for developing a balanced geologic mapping program that meets Federal needs while simultaneously fostering State needs; (3) the responsibilities accruing to the State Geological Surveys, with particular emphasis on mechanisms that incorporate their needs, missions, capabilities, and requirements into the nationwide geologic mapping program; (4) the specific role, responsibilities, and membership of the advisory group; (5) mechanisms for identifying short-term and long-term priorities for each component of the geologic mapping program; the rest of the paragraph is self-explanatory; (6) a mechanism for adopting scientific and technical map standards for preparing and publishing general-purpose and special-purpose geologic maps to assure uniformity of cartographic and scientific conventions and provide a basis for judgement as to the comparability and quality of map products; and (7) a mechanism for monitoring the inventory of published and current mapping investigations nation-wide in order to facilitate planning and information exchange and to avoid redundancy.

Subsection 6(a) provides that the U.S. Geological Survey shall establish a national geologic-map data base. Such data base shall be a national archive that includes all maps developed pursuant to this Act, the data base developed pursuant to section 5(e)(2) (B), (C), (D), and (E), and other maps and data as the U.S. Geological Survey deems appropriate.

Subseciton 6(b) provides that geologic maps contributed to the National Archives should have standardized format, symbols, and technical attributes so that archival information can be assimilated, manipulated, accessed, exchanged, and compared efficiently and accurately.

Section 7 is self-explanatory.

Section 8 provides for the authorization of appropriations and is self-explanatory.

COST AND REGULATORY CONSIDERATIONS

The following estimate of costs of this measure has been provided by the Congressional Budget Office:

U.S. CONGRESS,
CONGRESSIONAL BUDGET OFFICE,
Washington, DC, November 7, 1991.

Hon. J. BENNETT JOHNSTON,
Chairman, Committee on Energy and Natural Resources,
U.S. Senate, Washington, DC.

DEAR MR. CHAIRMAN: The Congressional Budget Office has reviewed S. 1179, the Geologic Mapping Act of 1991, as ordered reported by the Senate Committee on Energy and Natural Resources on October 30, 1991.

Enactment of S. 1179 would not affect direct spending or receipts. Therefore, pay-as-you-go procedures would not apply to the bill.

If you wish further details on the estimate, we will be pleased to provide them.

Sincerely,

ROBERT D. REISCHAUER,
Director.

CONGRESSIONAL BUDGET OFFICE COST ESTIMATE

1. Bill number: S. 1179.
2. Bill title: Geologic Mapping Act of 1991.
3. Bill status: As ordered reported by the Senate Committee on Energy and Natural Resources on October 30, 1991.
4. Bill purpose: S. 1179 is designed to stimulate the production of geologic map information in the United States. The bill would require the Secretary of the Interior to establish a nationwide geologic mapping program to be carried out by the U.S. Geological Survey, individual state geological surveys, and scientists from the academic community. The bill would direct the Secretary to appoint a geologic mapping advisory group, and would require the U.S. Geological Survey to establish a national geologic map data base.
5. Estimated cost to the Federal Government:

[By fiscal year, in millions of dollars]

	1992	1993	1994	1995	1996
Authorization level	37	43	49	56	0
Estimated outlays	18	47	58	59	3

The costs of this bill fall within budget function 300.

Basis of estimate: CBO assumes that all of the funds authorized for each fiscal year would be appropriated. Spending is projected to occur at rates similar to spending for other U.S. Geological Service programs except in the first two years of the program. Because S. 1179 would authorize a new program, CBO estimates that spending would be slower than the average in the first two years (as start-up activities are conducted) but would increase over time as the program reaches full operational level.

6. Pay-as-you-go considerations: The Budget Enforcement Act of 1990 sets up pay-as-you-go procedures for legislation affecting

direct spending or receipts through 1995. CBO estimates that enactment of S. 1179 would not affect direct spending or receipts. Therefore, pay-as-you-go procedures would not apply to the bill.

7. Estimated cost to State and local governments: None.

8. Estimate comparison: None.

9. Previous CBO estimate: None.

10. Estimate prepared by: Patricia A. Conroy.

11. Estimate approved by: C.G. Nuckols, for James L. Blum, Assistant Director for Budget Analysis.

REGULATORY IMPACT EVALUATION

In compliance with paragraph 11(b) of rule XXVI of the Standing Rules of the Senate, the Committee makes the following evaluation of the regulatory impact which would be incurred in implementing S. 1179. The bill is not a regulatory measure in the sense of imposing government-established standards or significant economic responsibilities on private individuals and businesses.

No personal information would be collected in administering the program. Therefore, there would be no impact on personal privacy.

Little, if any, additional paperwork would result from the enactment of S. 1179 as amended.

EXECUTIVE COMMUNICATIONS

On July 17, 1991, the Committee on Energy and Natural Resources requested legislative reports from the Department of the Interior and the Office of Management and Budget setting forth the executive views on S. 1179. The reports had not been received at the time this report was filed. When the reports become available, the Chairman will request that they be printed in the Congressional Record for the advice of the Senate.

Following is the Department of the Interior's statement at the July 30, 1991, hearing:

STATEMENT OF DR. DALLAS L. PECK, DIRECTOR, U.S. GEOLOGICAL SURVEY, DEPARTMENT OF THE INTERIOR

Mr. Chairman, I am pleased to be here today to discuss the Geologic Mapping Act of 1991, S. 1179. Geologic maps provide fundamental earth science information which influences much of the fabric of our nation's basic economy: Geologic maps have provided information on the distribution of mineral and energy resources and on the setting of ground water resources. They are increasingly providing essential information for sequential land-use planning and decision making. With the advent of sophisticated geographic information systems, the utility of geologic map information is growing as the source of primary data on which to base studies of societal issues, such as the rounting of transportation corridors, analyses of the distribution of minerals which affect human health, remediation of environmental contamination, and analyses of the responses of the earth's surface to natural hazards.

We are pleased, Mr. Chairman, with your acknowledgement of the necessity of a comprehensive geologic mapping program to meet the needs of our Nation. You and your staff are to be commended for their work in developing S. 1179. The proposed bill re-

flects the substance of our present program activities in gologic mapping. It is a pleasure to have this opportunity to consider further development of the program concept and to clarify issues in meeting such a national need.

However, the Administration cannot support S. 1179 for two reasons: (1) it is not necessary because it duplicates the authorization Congress provided in 1879, when it passed our Organic Act (43 USC 32(a)); and (2) the funding levels run counter to those of the Administration and to the efforts of Congress to move in the direction of a balanced budget.

A geologic map is a graphic information display that uses a combination of colors, lines, and symbols to depict the geologic setting of an area and to interpret the events which shaped that setting (Exhibit 1). The graphic display not only describes bedrock and surficial units and geologic structures visible at the surface but also forms a three-dimensional model that predicts the configuration of rock bodies and structures in the subsurface. This combination of descriptive and predictive information makes the geologic map a powerful tool, from which primary and specialized secondary information regarding earth materials and structures can be derived. A general purpose geologic map can be viewed as a first-order information layer that can be combined with information layers from other geologic, geographic hydrologic, or demographic disciplines. When applied in digital format, the general purpose geologic map becomes an indispensable data set in a geographic information system.

For 112 years, the U.S. Geological Survey has been a major source of geologic mapping and geologic maps for the Nation. Through those years, geologic map information has been cornerstone of many activities in the Geological Survey as we have provided a full range of earth science information on the Nation's land surface, natural resources, and earth hazards. As part of its mission, the USGS continues its commitment to provide the highest quality of earth science information possible for the Nation through an effective program of geologic mapping.

State geological surveys, some universities, industry, and others have also produced geologic maps, for geologic maps are fundamental to industry, commerce, and government. But the preparation of geologic maps have not kept pace with the need for the data. A study by the Earth Sciences Board of the Natioanl Academy of Sciences, published in 1988, described the need and importance of geologic maps and pointed out that the publication of geologic maps declined during the previous decade (Exhibit 2). In part, the decline resulted from the completion of a major cooperative program between the U.S. Geological Survey and the State of Kentucky to map the geology of that entire State. The USGS did most of the geologic mapping on that project, and the State and the USGS shared the cost. That cooperative mapping program was one of the most successful regional geologic mapping efforts undertaken in the United States; it is an example of the capability and expertise present within the USGS to carry out major mapping requirements. During the 1980's, financial and human resources in Federal and State geological surveys shifted from basic geologic mapping to site-specific or project-related studies. At the same time, demand

for the primary data provided by geologic maps increased. Clearly renewed emphasis on geologic mapping and production of geologic maps was needed.

From plans developed in response to that identified demand, the Department of the Interior and the Office of Management and Budget approved the formation by the USGS of a National Geologic Mapping Program in 1986. That program became a reality in Fiscal Year 1988, with the objectives not only to accelerate geologic mapping in the USGS, but also to address the need and requirements for geologic maps by other Federal agencies, States, and industry. The USGS National Geologic Mapping program was established with three principal elements:

(1) Federal geologic mapping, under which the USGS performs geologic mapping in areas of importance to national needs;

(2) Investigations in support of geologic mapping, including geochronologic studies by isotopic and paleontologic methods to determine the ages and isotopic signature of materials mapped, and studies of the processes that affect the distribution of earth materials; and

(3) Cooperative geologic mapping, in which States and the USGS share equally through funding awards and/or in-kind services the cost of geologic mapping in individual States.

Refocusing USGS efforts in the National Geologic Mapping Program is achieving a number of significant results. First, the USGS has significantly increased the extent of geologic mapping across the Nation in the Federal program. Second, through reducing the lead time necessary to prepare geologic maps for publication, the USGS has stabilized the publication rate of geology maps, and we can now anticipate an increase of map production (Exhibit 2). Third, the USGS is increasingly meeting requirements for geologic mapping through cooperation with other Federal agencies (Exhibit 3). Program priorities have been, and are being, readjusted to meet those requirements. Geologic mapping by the USGS will meet land-use and regulation requirements, environmental regulation requirements, and needs for data for large areas of federally-managed lands. Lastly, we have made significant progress in increasing the Cooperative Geologic Mapping component (COGEOMAP) so that geologic mapping studies are in progress in 36 States (Exhibit 4). Funding to the COGEOMAP component has increased significantly since the inception of the program.

An important reason for the increase in funding during the past fiscal year for the existing National Geologic Mapping Program is the clear demonstration of the cost effectiveness of geologic mapping in solving problems of national and local concern. The USGS has demonstrated through an economically rigorous benefit/cost study that using geologic maps in early stages of planning for projects such as highway construction (Exhibit 5), landfill siting, and city planning can effect savings of millions of dollars for each project. Application of geologic maps to the planning process throughout the public sector has the potential for realizing billions of dollars of savings across the Nation.

Under Office of Management and Budget Circular A-16, which defines roles of Federal agencies in the coordination of spatial data

developed in whole or in part using Federal funds, the USGS is responsible for coordinating geological data and geologic map requirements analysis. The level of support necessary to accomplish these responsibilities would be greatly increased under the envisioned expanded program. Under Circular A–16, geologic mapping supported by Federal funds must conform to national geologic map standards. Such standards have been developed by the USGS with cooperation from State geological surveys. Application of those standards in any expanded national program would require considered attention by all participating parties. Through coordination by the USGS, data produced by the program can be archived by Federal and State agencies.

Geologic maps are produced for the Nation at scales that are unique to the problems addressed by the maps. On one hand, for example, a geologic map user may require detailed information to site an underground storage tank; a large-scale map (1:200 to 1:24,000; Exhibit 6) would be needed. On the other hand, a geologic map user may need to examine the distribution of a limestone unit across parts of several counties; a smaller-scale map (1:100,000; Exhibit 7) would be needed in this instance. Although geologic-map data would be developed at scales necessary to resolve problems, original maps could be prepared at 1:24,000 for most land regions of the United States. From such data, a national geologic-map data set would be developed at a scale of 1:100,000. Digital geologic maps capable of use in interactive geographic information systems are required by government, commerce and industry, and can be developed from original data produced by the program at scales appropriate to applications of the data.

Thank you, Mr. Chairman, for the opportunity to express the Administration's views on this important program. I shall be pleased to respond to any questions you may have.

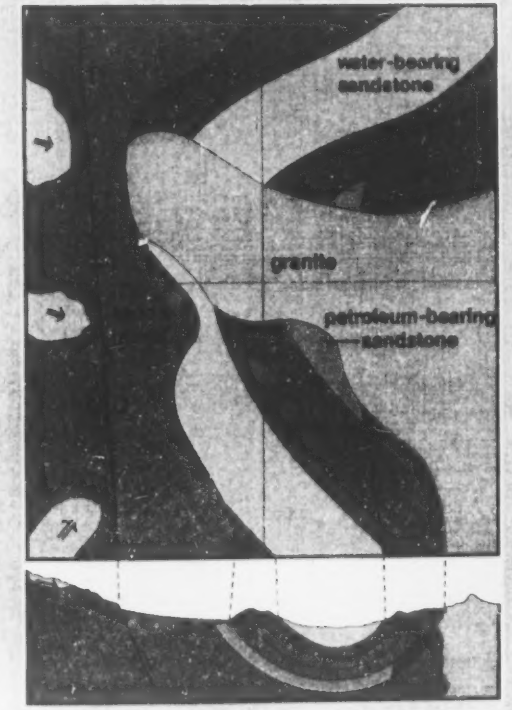
GEOLOGIC MAPS: PRIMARY DATA BASE FOR THE EARTH SCIENCES

SUPPORT RESEARCH AND DECISIONS BY:

- Government
- Industry
- Academia

IDENTIFY GEOLOGIC HAZARDS:

- Earthquake faults
- Landslides
- Land subsidence
- Radon
- Volcanoes



LOCATE NATURAL RESOURCES:

- Water
- Energy
- Mineral
- Industrial

FACILITATE LAND-USE PLANNING:

- Critical facilities
- Hazardous-waste repositories
- Urban development

G-500-87

Exhibit 1

EXHIBIT 1: GEOLOGIC MAPS: PRIMARY EARTH-SCIENCE DATA BASES

- The geologic map is the basic tool of the earth scientist, explorationist, civil engineer, and planner: it forms the foundation for specialized investigations of geologic hazards and earth resources and is the starting point for topical studies of the earth's composition and structure, internal and external processes, and the changes it has undergone through geologic time.

- A geologic map shows the distribution of rock formations and surficial deposits exposed in an area, and provides essential data about the shape and size of rock bodies (depicted by different colored units), the character of boundary zones between them (depicted by black lines that separate colored units), and the orientation of layering, fracturing, warping, and faulting (depicted by various symbols).

- With these essential pieces of information, a geologic map provides the framework for analyzing the physical makeup of an area, and permits reasonable interpretations to be made about the distribution of rock bodies at depth and about the area's geologic history.

- The standard geologic map is a multi-purpose map: that is, it conveys information about all the geologic features present in an area--not just a single feature as do special-purpose maps.

- The multi-purpose geologic map serves as a starting point for specialists interested in a particular geological aspect of an area. Thus, the multi-purpose geologic map can:

    - alert slope-failure specialists to the presence of landslides (*Gray*);

    - alert seismic-safety specialists to the presence of active faults or geologic hazards induced by earthquake ground shaking;

    - alert mineral-resource specialists to the possibility that ore-bearing rocks might be present in an area where, for example, granite (*Pink*) has intruded limestone (*Green*);

    - guide land-use planners in the siting of toxic-waste repositories and critical facilities (here sited in granite, *Pink*) and the development of urban corridors (here sited in surficial deposits, *Yellow*);

    - assist in the discovery and utilization of ground-water resources that occur in saturated sedimentary rocks like sandstone (*Blue*).

- General-purpose geologic maps thus provide a primary data base for decisionmaking in government, academia, and industry, no matter what the specialized need. The U.S. Geological Survey's National Geologic Mapping Program is designed to increase the systematic production of high-quality multi-purpose geologic maps necessary to such decisionmaking.

U.S. Geological Survey
National Geologic Mapping Program
[07 . 08 . 91]

Exhibit 2

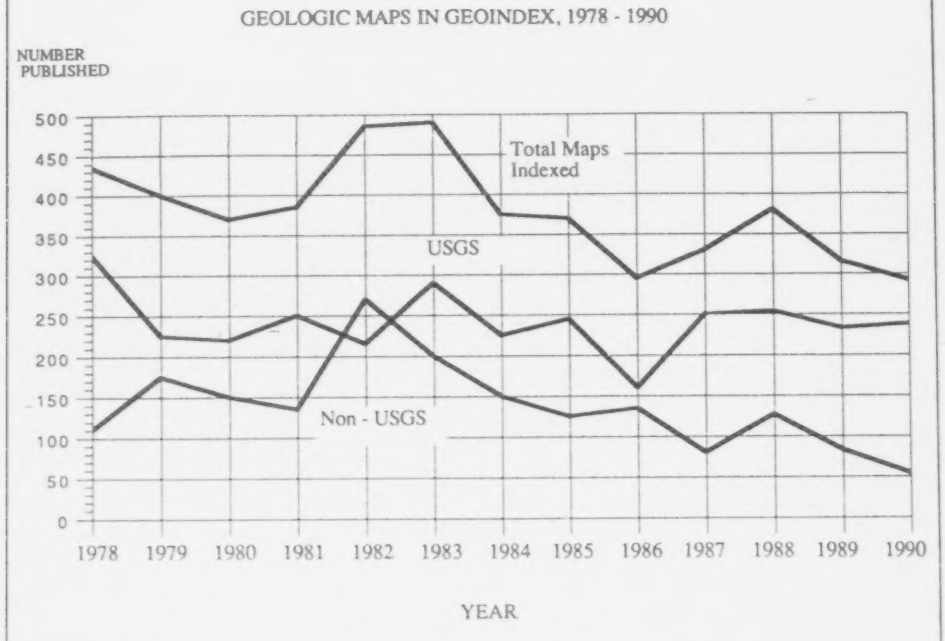


Figure. Numbers of geologic maps catalogued in GEOINDEX for calendar years 1978 - 1990, published at scales of 1:10,000 to 1:250,000. The steep decline in the total number of maps since 1983 nearly parallels the decline in non - USGS maps.

Exhibit 3

PRIORITY REQUESTS FOR
GEOLOGIC MAP-BASED INFORMATION
FROM OTHER FEDERAL AGENCIES
USFS
BLM
EPA
NPS GEOTHERMAL
MULTI-AGENCY GEO-HAZARDS
MULTI-AGENCY AGRICHEMICAL
G-602-81

EXHIBIT 3: PRIORITY REQUESTS FOR GEOLOGIC MAP-BASED INFORMATION FROM OTHER FEDERAL AGENCIES

Establishing priorities for geologic mapping is accomplished partly by determination of the needs of other Federal agencies. In response to U.S. Geological Survey (USGS) outreach to 23 Federal agencies, requirements have been received from USFS, BLM, EPA, NPS, multiple agencies concerned with agrichemical issues, and multiple agencies concerned with geohazards.

Green - **The U.S. Forest Service** (DOA) has requested mineral assessment studies be conducted during FY 1990-1993 in 11 national forests located within 9 States. These studies require geologic-map information on the distribution of mineral occurrences and the host rocks or surficial deposits in which they occur.

Blue - **The Bureau of Land Management** (DOI) has determined a need for large-scale geologic mapping in 58 areas within 4 Rocky Mountain States over the period FY 1990-1995. It has also requested mineral assessments in the Caliente, CA, and Roswell, NM, resource areas.

Yellow - **The Environmental Protection Agency** (EPA), through its National Mapping Requirements Program, has requested geologic-map information in support of its studies on groundwater quality, preservation of wetlands, and geologic hazards.

Red - **The National Park Service** (DOI) submitted requests for large-scale geologic mapping in areas of geothermal features occurring in 16 national parks affecting 11 States including Alaska and Hawaii.

Blue - Stripes **Geohazards in southern California**: A geologic map data base for southern California has been identified as a priority by several Federal agencies (including BLM, USFS, EPA, U.S. Navy), the state of California, and various local agencies. This map data base is needed for land-use planning decisions including those related to geohazards.

Orange - Stripes **Agricultural chemicals and groundwater vulnerability in the Midwest:** Requirements in the midwest for geologic-map information bearing on the transport and concentration of agricultural chemicals were expressed as a result of workshops attended by multiple agencies including the Agricultural Research Service (DOA) and the Soil Conservation Service (DOA), USGS (DOI), and the affected States.

COST-ESTIMATE: The geologic mapping requests received to date, just from these sources, represent an estimated 10-fold increase over the present program level. This estimate assumes that: a) 50% of the mapping is already available at proper scale and quality from previous studies; and b) new mapping is done at intermediate scale (1:100,000).

G-608-91

U.S. Geological Survey
National Geologic Mapping Program
[07 08 91]

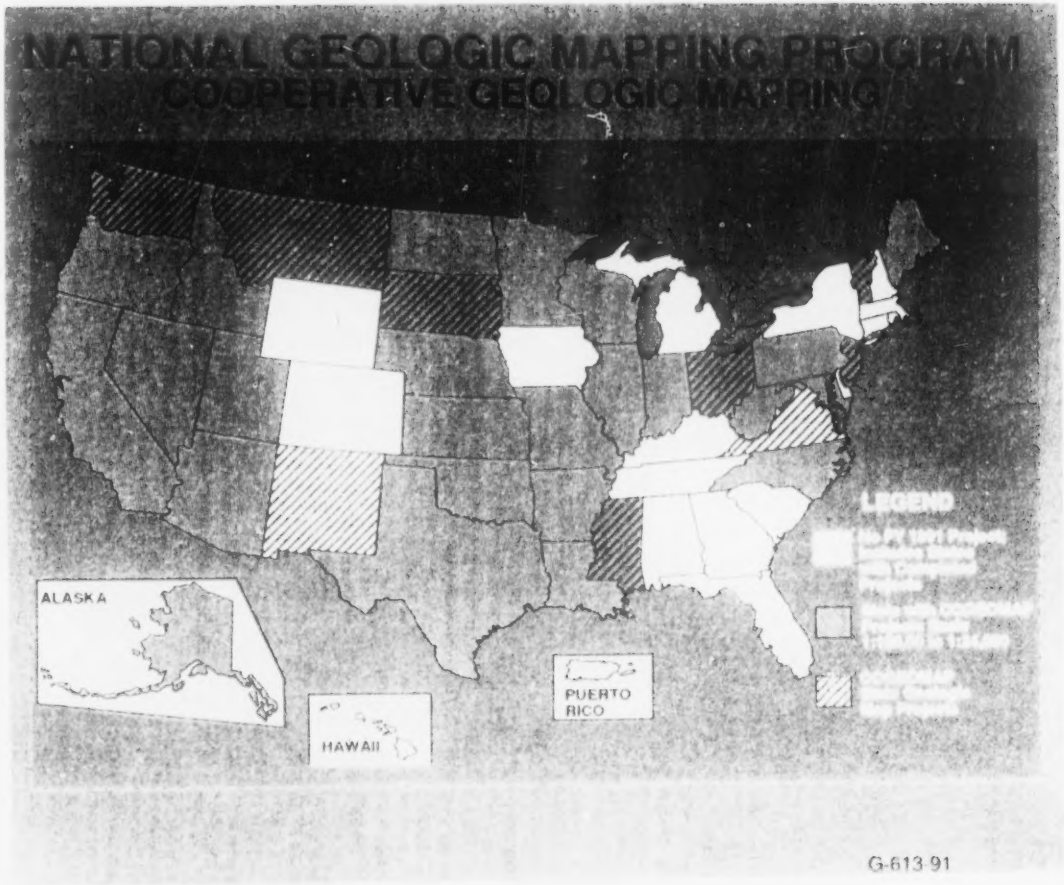

NATIONAL GEOLOGIC MAPPING PROGRAM
COOPERATIVE GEOLOGIC MAPPING
LEGEND
ALASKA
HAWAII
PUERTO RICO
G-613 91

Exhibit 4

EXHIBIT 4: COOPERATIVE (FEDERAL/STATE) GEOLOGIC MAPPING NATIONAL GEOLOGIC MAPPING PROGRAM

The USGS has a long history of cooperative geologic mapping with State geological surveys. **COGEOMAP** was formally initiated in FY 1985 and now forms a vital component of the **NATIONAL GEOLOGIC MAPPING PROGRAM**. **COGEOMAP** provides for cooperative geologic mapping in high priority areas of mutual concern to Federal and State government. It also supports compilation of State-wide geologic and geophysical maps. **COGEOMAP** effectively doubles the effort possible by either a State or the USGS through sharing of funds and personnel.

White - States with no ongoing project in FY 1991. Includes states in which cooperative geologic mapping projects have been completed, such as Alabama, Kentucky, Massachusetts, and Connecticut.

Orange - States with **COGEOMAP** Projects in FY 1991 primarily at scales of 1:100,000 to 1:24,000. The USGS and thirty-one states have ongoing cooperative geologic mapping projects that range in size from 100 square miles to 6,000 square miles and involve such issues as landuse planning, resource availability, geologic hazards, and groundwater.

Red - Stripes **COGEOMAP** State Geologic Map Projects. These 9 projects have a formal goal of producing a new or revised State Geologic Map. One State (Arizona) has already published a new State geologic map, and geophysical maps for New Mexico, Nevada, and Ohio are completed and published.

To date, a total of 45 States have participated in cooperative geologic mapping projects with the USGS indicating that a large majority of the States are enthusiastic about the **COGEOMAP** component of the **NATIONAL GEOLOGIC MAPPING PROGRAM**.

G-613-91

U.S. Geological Survey
National Geologic Mapping Program
[07 . 08 . 91]

UTILITY OF GEOLOGIC MAPS

ISSUE: COST EFFECTIVENESS IN TRANSPORTATION PLANNING

Digital Geologic Map:
Eastern Loudoun County, Virginia

Digital Derivative Map:
Excavatibility

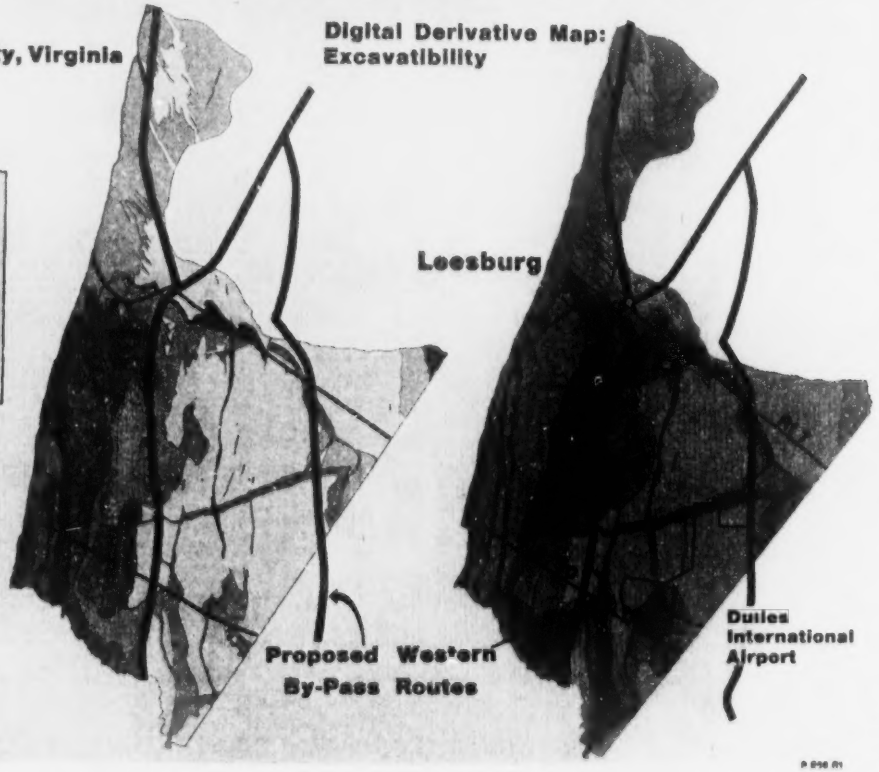


EXHIBIT 5

EXHIBIT 5: UTILITY OF GEOLOGIC MAPS

ISSUE: COST EFFECTIVENESS IN TRANSPORTATION PLANNING

The **National Geologic Mapping Program** is engaged in an ongoing **Benefit/Cost** analysis to establish the social value of geologic map information. This is being done through the use of Case **Studies** that each demonstrates the utility of a specific geologic map for a specific social issue. One such issue is the cost effective planning of transportation corridors.

DIGITAL GEOLOGIC MAP: EASTERN LOUDOUN COUNTY, VIRGINIA

A portion of the proposed Washington Bypass would pass through eastern Loudoun County in northern Virginia. This part of the county is underlain by a complex set of geologic units that are shown in somewhat simplified form on this exhibit.

Light Blues - Siltstones and claystones (shales) of the Mesozoic Culpeper Basin. The geologic map delineates the distribution of old lake beds that form "swelling clays", units that can disrupt highway surfaces and significantly increase maintenance costs.

Pinks and Light Brown - Igneous rocks (diabase and basalt) that have intruded or are interlayered with the sedimentary rocks of the Culpeper Basin. The igneous rocks, especially diabase, are extremely hard to excavate but do form a stable road base.

Dark Blues and Greens - Sandstones and conglomerates along the western edge of the geologic map. These sedimentary rock units are also difficult to excavate due to their large average grain size and high degree of induration.

DIGITAL DERIVATIVE MAP: EXCAVATIBILITY

The detailed distribution of all the geologic units and their engineering characteristics are archived digitally and therefore can be used to construct special-purpose derivative maps, in this case based on excavatibility.

Yellow - Easiest units to excavate and therefore minimum highway construction costs for this area. Some areas within these units do contain beds of "swelling clays", however, and maintenance cost would increase if these areas were not avoided.

Light Orange - Harder units to excavate, highway construction costs increase by about 5 percent over the yellow. The light orange includes sandstones, conglomerates, and the highly indurated areas adjacent to the diabase (hornfels).

Dark Orange - Hardest units to excavate, highway construction costs increase by at least 10 percent over the yellow. The dark orange includes the igneous rock units (diabase and basalt) and some of the highly indurated sedimentary rock units adjacent to them.

The **Benefit/Cost** analysis demonstrates that Net benefits gained by using the geologic map information in the planning phase are high compared to the cost of producing the geologic map.

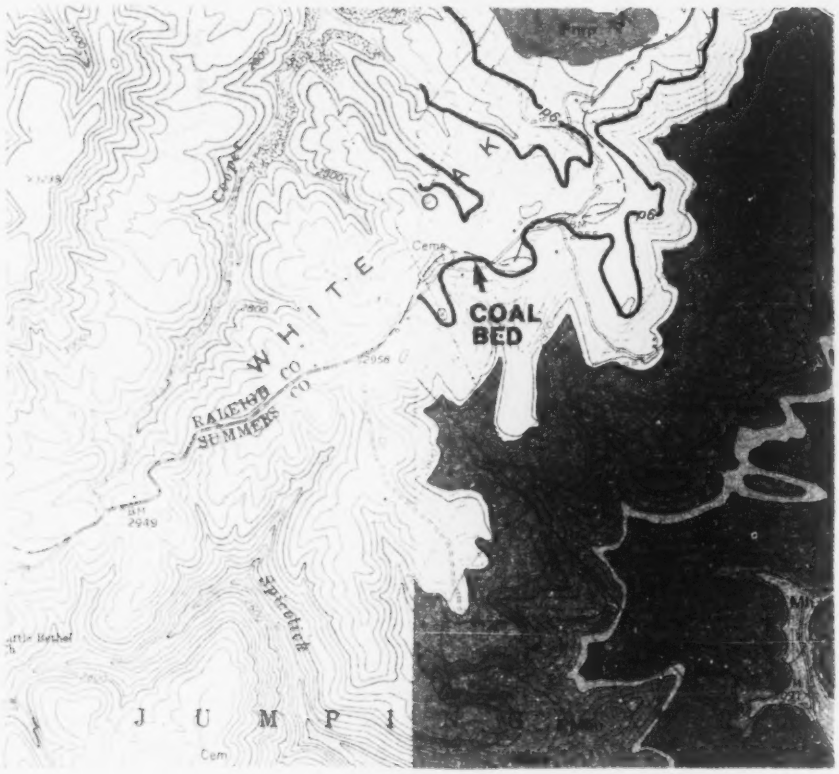
G-638-91

U.S. Geological Survey
National Geologic Mapping Program
[07 . 08 . 91]

Exhibit 6

TOPOGRAPHIC AND GEOLOGIC MAP DATA

SCALE 1:24,000



1 MILE

TOPOGRAPHIC DATA

- *LANDFORMS
- *STREAMS
- *ROADS

GEOLOGIC DATA

- *ROCKS AND SEDIMENTS
- *COAL BEDS
- *GEOLOGIC HISTORY

SHADY SPRING QUADRANGLE, WEST VIRGINIA

EXHIBIT 6: TOPOGRAPHIC AND GEOLOGIC MAP DATA SCALE 1:24,000

Maps are graphic images that portray selected features of the earth's surface. Two very useful types of maps are topographic and geologic maps. This illustration compares topographic and geologic map data, using as an example a portion of the Shady Spring 7-1/2-minute quadrangle, Raleigh and Summers Counties, West Virginia. The left side of the map shows topographic data and the right side shows geologic data. The scale of the map is 1:24,000, or 1 inch on the map = 2,000 feet on the ground.

Topographic maps portray the shape and elevation of the land surface through the use of contour lines (*brown*). They also show water features such as streams and lakes (*blue*), forested areas (*green*), and various kinds of manmade features (*special symbols*). The manmade features shown on this map include buildings, roads, and a power line.

Geologic maps, in contrast, portray the physical composition and structure of the land, and provide a basis for interpreting the geologic history. On geologic maps, the rocks and sediments that make up the land are divided into units of different composition and geologic age, and the areas covered by each unit are distinguished by a label and color. Other important geologic features such as faults, folds, and special rock layers also can be shown. On this map, for example, economically significant coal beds are shown as heavy black lines. To ensure that the geologic features are accurately located, most geologic maps are compiled and printed on topographic base maps.

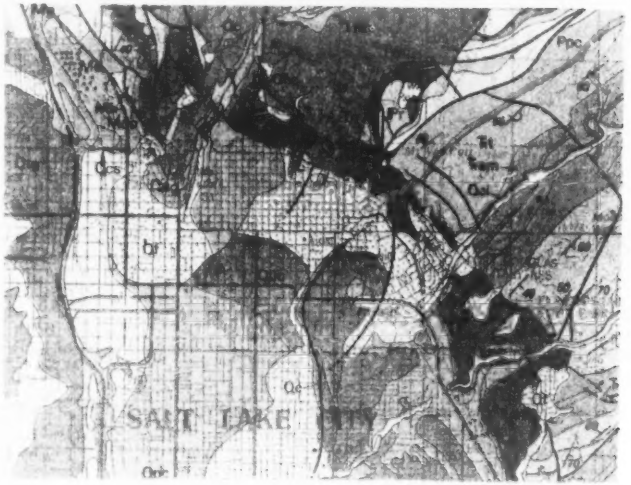
- The information shown on geologic maps can be used to address numerous issues of social, economic, and scientific importance. These issues include the assessment and development of mineral, energy, and water resources, the reduction of losses due to geologic hazards such as earthquakes and landslides, construction siting, and land-use planning.

- The scale of this map (1:24,000) is the most detailed generally available for topographic maps in the United States. On maps of this scale, the resolution is such that topographic and geologic features as small as about 50 feet across can be accurately located and portrayed. This map scale is useful for local applications in small geographic areas. There are 53,935 1:24,000 scale quadrangles in the U.S. (exclusive of Alaska) and about 10% have modern, publicly-available geologic maps.

U.S. Geological Survey
National Geologic Mapping Program
[07 . 08 . 91]

TOPOGRAPHIC AND GEOLOGIC MAPS—A COMPARISON

SCALE 1:100,000



5 MILES

TOPOGRAPHIC MAP
- *ROADS
- *URBAN AREAS
- *LANDFORMS

GEOLOGIC MAP
- *ROCKS AND SEDIMENTS
- *FAULTS
- *GEOLOGIC HISTORY

SALT LAKE CITY AREA, UTAH

EXHIBIT 7: TOPOGRAPHIC AND GEOLOGIC MAPS--A COMPARISON SCALE 1:100,000

Maps are graphic images that portray selected features of the earth's surface. Two very useful types of maps are topographic and geologic maps. This illustration compares the kinds of information shown on topographic and geologic maps using, as an example, the Salt Lake City area, Utah. The map on the left is a topographic map, and the map on the right is a geologic map of the same area. The scale of these maps is 1:100,000, or 1 centimeter on the map = 1 kilometer on the ground.

Topographic maps portray the shape and elevation of the land surface through the use of contour lines (shown in brown). They also show water features such as streams and lakes (shown in blue), urban areas (shown in gray), forested areas (shown in green), and various kinds of manmade features (shown by special symbols). The manmade features shown on this map include highways (red), other roads and streets (gray), and special buildings such as the State Capitol and a hospital.

Geologic maps portray the physical composition and structure of the land, and provide a basis for interpreting the geologic history. On geologic maps, the rocks and sediments that make up the land are divided into units of different composition and age of formation, and the areas covered by each unit are distinguished by a label and color. Other important geologic features such as faults, folds, and special rock layers also can be shown. Several faults, for example, are shown on this map as heavy black lines. Some of these faults cut through units of geologically young sedimentary deposits (shown in shades of yellow) and therefore have been seismically active in the recent geological past. To ensure that the geologic features are accurately located, most geologic maps are compiled and printed on topographic base maps.

The information shown on geologic maps can be used to address numerous issues of social, economic, and scientific importance, including:

- assessment and development of mineral, energy, and water resources,
- the reduction of losses due to geologic hazards such as earthquakes and landslides,
- construction siting,
- and land-use planning.

The scale of this map (1:100,000) is about four times smaller (less detailed) than the 1:24,000 scale of the map shown in the companion illustration. At a scale of 1:100,000, the resolution is such that topographic and geologic features as small as about 100 meters across (about the length of a football field) can be accurately located and portrayed. This map scale is useful for regional applications over large geographic areas.

U.S. Geological Survey
National Geologic Mapping Program
[07 . 08 . 91]

CHANGES IN EXISTING LAW

In compliance with paragraph 12 of rule XXVI of the Standing Rules of the Senate, the Committee notes that no changes in existing law are made by the bill S. 1179 as reported.

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